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AUTHOR(S):

Winarto, Yunita T.

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The Evolutionary Changes in Rice-crop Farming: Integrated Pest Management in Indonesia, Cambodia, and Vietnam

Yunita T. WINARTO*

Abstract

From the time the Integrated Pest Management (IPM) Programme—initiated by the FAO—was introduced in Indonesia in early 1990 and other Asian countries afterwards, a gradual change in IPM farmers' knowledge, practices, empowerment, and dignity has been occurring. In line with the aims of the program to introduce knowledge, stimulate farmers' own curiosity, and improve their decision making ability, the implication of this program for farmers' knowledge and farming practices has been significantly different from the Green Revolution program and other technological interventions in crop farming. An "evolutionary" or gradual change rather than a "revolutionary" one or sudden change is going on among the IPM farmers in several countries in Southeast Asia. Not only are their technical understandings of growing crops enriched and modified, but also their creativity, dignity, and self-confidence are enhanced. Nevertheless, knowledge enrichment, production, implementation, and transmission are not simple processes. They are embedded in the local settings and within the course of the agricultural development and history in each locale. Some similarities and many variations are found in different countries in Southeast Asia. This paper examines these phenomena by looking at the evolutionary changes found in IPM farmers' knowledge and practices in rice-crop farming in Indonesia, Cambodia, and Vietnam.

Keywords: Integrated Pest Management, rice-crop farming, evolutionary changes, farmers' knowledge and practices, comparative perspective, interpretation schemas

Producing Knowledge, Improving Dignity: An Introduction

For thousands of years farmers have been the "producers" of knowledge, the primary innovators and experimenters in food-crops farming [see Amanor *et al.* 1993; Conway 1998]. The freedom to carry out experimentations and strategies in their world of crop farming has been the basis of their dignity and self-confidence. "We were free to make our own decisions of what to plant, when to plant, and how to plant," said an old farmer on the north coast of West Java, Indonesia, referring to the time prior to the government's intervention into his

* Department of Anthropology, Faculty of Social and Political Sciences, University of Indonesia, Depok, Indonesia, e-mail: winyun@indo.net.id

life as a farmer. He was one of the few farmers left in the early 1990s who was able to identify various traditional rice varieties, including the glutinous rice. A rice-field environment consisting of a very diverse nature of crops' growth was the result of each farmer's decision in planting various kinds of rice varieties. This was the very significant different feature of rice farming from the recent condition where only several high yielding varieties are grown. Even though he admitted that cultivating rice in his youth was not as easy as recent times since it took longer to harvest, required the employment of more labourers, was subject to more religious taboos, and the yields were not as high as today, his life was much in peace. Other farmers shared the same thoughts and feelings. "Now, we are always anxious of what are going to happen in our fields, we are restless. . . ," argued another farmer. These were the rice farmers' remark after three decades experiencing the enforced adoption of "the government's varieties," the "short-stem ones" [also see Winarto 1996; 2004]. Such expressions reveal that cultivating rice is not only a matter of technical skills and know-how, but also entails other things related to personal aspects. Unfortunately, farmers' knowledge, emotional feeling, dignity, confidence, and belief were not taken into account when the modern high yielding varieties and their technological packages were introduced into their lives [see Fox 1991; Shiva 1993; 1995].

In the last two decades, a growing number of scientists and experts from various disciplines have voiced their warnings that priority and high agenda of any development program should be put on emphasizing farmers' needs and environmental sustainability. It is urgent to appreciate and incorporate local knowledge in its dynamics and diverse natures, and to consider knowledge interface between various agencies by understanding the complex social-cultural-political settings. It is also necessary to enhance farmers' empowerment while preserving biodiversity and sustainable natural resource management [see Brokensha *et al*. 1980; Richards 1985; Chambers *et al*. 1989; Moock 1992; Arce and Long 1992; Amanor *et al*. 1993; Scoones and Thompson 1994; Sumberg and Okali 1997; Berkes 1999; Pottier 2003]. In reality, farmers' products are commodities to meet local-national demands, as well as global needs of feeding an ever-growing population. Conway [1998: 41] therefore strongly argues for the "Doubly Green Revolution," "a revolution that is even more productive than the first Green Revolution and even more 'green' in terms of conserving natural resources and the environment." However, he emphasizes that the success will rely on:

> . . . the application of new scientific and technological discoveries in a manner that is environmentally sensitive and above all, . . . the creation of new partnerships between scientists and farmers that will respond to the needs of the poor. [Conway 1998: 41–42]

He does not neglect entirely the need to pay attention seriously to farmers' dignity and self-confidence. Referring to the story of a poor Bangladesh woman who was able to change her life from the financial support she got, Conway [*ibid.*: 301–302] argues for the advantageous improvement that, "[i]f the experience was multiplied for the poor and hungry throughout

the developing world it would add up to a revolution." This statement reveals the urgent need for collaborating with farmers to improve their dignity and self-confidence for a second "revolution" to occur.

In addition to the urgent needs to feed the increased population, a paradigm shift in agricultural development is crucial in returning farmers' dignity and confidence, not only as crop growers, but also as knowledge producers. My question is how could that be achieved in the current constellation of power relations, the persisting globalization of resource management and scientific agricultural technology [see Berkes 1999], international aid policies, and the complex nature of social-cultural-economic-political settings of various actors involved in this process? Would evolutionary changes occur following the efforts of building up "partnership" with farmers that may lead to an improvement in their dignity while feeding up the growing population? A thorough study is indeed necessary to answer those questions.

In this paper I will examine cases of farmers' experience in the program that has the objectives on "making farmers experts" and able decision makers through the so-called Community Integrated Pest Management (CIPM) Programme in Asia. This is the program that has the aims of not only alleviating the negative implications of the Green Revolution, but also of shifting the paradigm: i.e. from enforcing farmers to achieve the targets of crop intensification program to facilitating them in enhancing their knowledge, improving their learning ability, and thus regaining their dignity, and empowering them in their own habitat [Pontius *et al*. 2002]. On the basis of my observation in Indonesia in the past decade, some evolutionary changes have occurred in farmers' knowledge and practices following the training program known as Farmer Field Schools (FFS) and its follow-up CIPM activities.[1] In this paper I describe the kinds of changes in farmers' knowledge and practices that have occurred, and how and why such changes have emerged by comparing and contrasting the cases of rice growers' experience in Indonesia, Cambodia, and Vietnam.[2]

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1) In this paper I concentrate on the changes experienced by the IPM farmers that would affect the growth of rice farming culture in the region. I argue that evolutionary instead of revolutionary changes are now taking place. For the paradigm and strategies of Community Integrated Pest Management in Asia that could be seen as "revolutionary" changes in putting farmers first on top of technology see Pontius *et al.* [2002]. In this paper, these changes would serve as the explanatory factor leading to the gradual changes in farmers' knowledge and practices.

2) My in-depth ethnographic studies on the implication of IPM in Indonesia were held in several villages on the north coast of West Java (in the villages of Ciasem Baru and Ciasem Tengah) as part of my Ph.D program at the Australian National University in 1990–92, my return visits there from 1996–2001, and in Central Lampung (in the district of Batanghari and Terbanggi Besar) in 1998–2000. I also did my observation on the activities held by the Indonesian IPM Farmers Association in 2002. My study in Cambodia and Vietnam was begun in 2003 in a preliminary survey in several farming communities in Kampong Chhnang province in Cambodia and Thai Binh province in Red River Delta, Vietnam, as part of the ongoing research under the Southeast Asian Studies Regional Exchange Collaboration Program (The Toyota Foundation and the Japan Foundation Asia Center) in 2003–04. As a follow up, I carried out my in-depth ethnographic study ↗

My field sites in the three countries are located in the major rice-growing areas with rice as the main crop. Secondary crops are grown by farmers in Central Lampung (Indonesia), Kampong Chhnang (Cambodia), and Thai Binh (Vietnam). All villages are located in the lowland area with irrigated rice fields in West Java and Central Lampung [see Winarto *et al*. 2000; Winarto 2004], non-irrigated rain-fed rice fields in the vicinity of Tonle-sap lake, Cambodia [see Nesbitt 1997], and irrigated lowland delta regions in North Vietnam [see Le Trong Cuc and Rambo 1993]. Rice is not only the major subsistence crop for local communities, but—in Indonesia and Vietnam—contributes significantly to national rice production. Thus, farmers in these two countries earn income in terms of cash from selling rice in the market. The Cambodian rice farmers do that only if they can produce some surplus from their harvests.

Even though my focus of observation and in-depth interview are directed to those who were recruited as participants in the IPM program, interviewing the non-IPM farmers also enriched my comparative understanding of the issues in question. The qualitative paradigm underlining my research methodology in an ethnographic field-work enabled me to discover the mechanisms and processes leading to changes in knowledge and practices, gain an insight understanding of the local meanings, sharpen my analysis, and improve my ability to contextualize the findings [see Creswell 1994; Winarto 1999; Huberman and Miles 2002].

Integrated Pest Management in Southeast Asia: A Comparative Perspective

Conway [1998: 215, 218] cites the success story of the Integrated Pest Management in Indonesia as the example of the most extensive involvement of farmers in controlling pest/disease in a participatory program. The IPM planners, however, do not perceive the program as focusing on controlling pest/disease alone by involving farmers as partners. More important than that, the basic IPM training program known as Farmer Field School (FFS) or "school without walls" provide farmers with an opportunity to learn and achieve greater control over the conditions they face every day in their fields. Pontius *et al*. [2002: 1] say that "[F]armers are thus empowered by field schools." In the current world, farmers have to face contending forces related to technology, politics, markets, and society. Technologies are also developed to increase aggregate national production and profits for those who promulgate the technologies. In such a situation, Pontius *et al*. [2002: 1–2] argue that:

> [F]armers need to be able to make their voice heard as sustainable ecological agriculture

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↘ in Cambodia and Thailand in 2004–05. I did my literature research during my fellowship as a Visiting Research Fellow at the Center for Southeast Asian Studies, Kyoto University in 2003–04.

> approaches a critical cross roads, [and they] . . . need to be able to understand the issues affecting their livelihood and contend in the debates these issues generate to guarantee that their interests are served.

Making farmers "experts" by mastering the ecological principles of their own fields, and empowering them through improving their own learning ability are the most important objectives of the program. Farmers' own discovery-learning process becomes the basic educational method of the "school" that serves as the starting point for institutionalizing IPM at the community level [*ibid.*].

On the basis of Indonesia's experience of implementing such a program, the FAO introduced the IPM Farmer Field School in other Asian countries from 1992–98, followed by the Community IPM Programme from 1998 onwards (see Map 1). The same educational method and curriculum of the Farmer Field School has been implemented in those various countries.[3] Not all of them, however, carried out the various follow-up activities within the Community IPM Programme.[4] Examples are Thailand and Laos.[5] Cambodia and Vietnam, on the other hand, have institutionalized a National IPM Programme within the body of the Ministry of Agriculture in their own countries,[6] and implemented both the Farmer Field School and the Community IPM Programme in some provinces.

In Cambodia, the government and agricultural officials prefer to name the program as the Integrated *Crop* Management on the basis of the need to improve farming practices for the entire stages of cultivating crops. Food security still constitutes a particular concern, even though there has been a progress in the Cambodian economics after long years of vio-

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3) The basic IPM Farmer Field School is a field based training lasts for a full cropping season with rice field as the primary learning material. As many as 25–30 participants are facilitated by facilitators (either the agricultural officials or farmer trainers) to meet once a week from 10–16 weeks. They learn to carry out agro-ecosystem analysis on the basis of experiential, participatory and learner-centred approach by comparing IPM with non-IPM treated plots. They also learn special topics related to local ecological conditions and problems emerging in their rice environment, or current needs of improving their cultivation practices, besides conducting a group-dynamics activity [see Pontius *et al*. 2002; Gallagher 2003].

4) Community IPM is intended to lay a foundation upon which FFSs alumni can establish a farmer-led IPM programs in a given village through: building a cadre of experienced farmer IPM trainers, implementing several FFSs plus other follow-up activities, and creating opportunities for IPM alumni/farmer IPM trainers to interact. For details of the objectives and activities of CIPM see Pontius *et al*. [2002: 30–31]; Ngin Chhay [2002] for CIPM program in Cambodia; and Vietnam National IPM Programme [2000; 2003].

5) Thailand incorporates Farmer Field School within the program of Pest Management Division of the Ministry of Agriculture and Cooperatives, without carrying out the Community IPM Programme in a special national program (Patcharee, personal communication 2003).

6) The Cambodian National IPM Programme is co-ordinated by the Department of Agronomy of the Ministry of Agriculture, Forestry and Fisheries (MAFF), while the Vietnam National IPM Programme is co-ordinated by the Plant Protection Department of the Ministry of Agriculture and Rural Development.

Map 1　FAO Community IPM Programme Member Countries
Source: [Pontius *et al.* 2002]

lence, genocide and large-scale destruction of people's life [Murshid 1998]. Crop farming is still at a subsistence level, and average productivity of crops among the Southeast Asian countries is the lowest [see Mabbet and Chandler 1995; Ngin Chhay 2002; Sophal and Acharya 2002; DANIDA IPM Training Project in Cambodia n.d.]. Addressing the need to increase rice production to obtain food security, the leading agricultural officials in Cambodia perceived the FAO CIPM Programme as a promising means to improve farmers' agro-ecological knowledge and cultivation practices. However, they also learned of the unintended problems of pesticides and fertilizers use in "modern" rice productions as occurred in Indonesia and the Philippines. The IPM programme was thus adopted to increase rice production in an environmentally sound and sustainable manner [National IPM Coordinator and FAO of the United Nations IPM 1998; Ngin Chhay 2002]. By the end of 2000, there were large, diverse and dynamic programs in place spread in 14 provinces [Röling *et al.* 2000; see Map 2]. DANIDA and Srer Khmer Organization—an independent non-profit organization—

are now facilitating CIPM in several provinces with its various activities [see Ngin Chhay 2002; FAO 2002].

After the improvement of agriculture under the *doi moi* program, Vietnam has been able to increase the rice output and has become the third largest rice exporter in the world market [Do Kim Chung and Kim Thi Dung 2002].[7] Nevertheless, the level of pesticide use also increased in conjunction with the use of chemical fertilizers. Despite this, Vietnam is still encountering poverty issue and rural development problems [Tran Thi Que 1998; Vietnam Development Report 2000; Yanagisawa and Kono 2001]. In line with the objectives of achieving higher yields and minimizing negative impacts on environment, Vietnam's government has been very serious in implementing IPM by conducting the FFS in all 61 provinces. Various CIPM activities have also been implemented in a number of provinces (see Map 3)

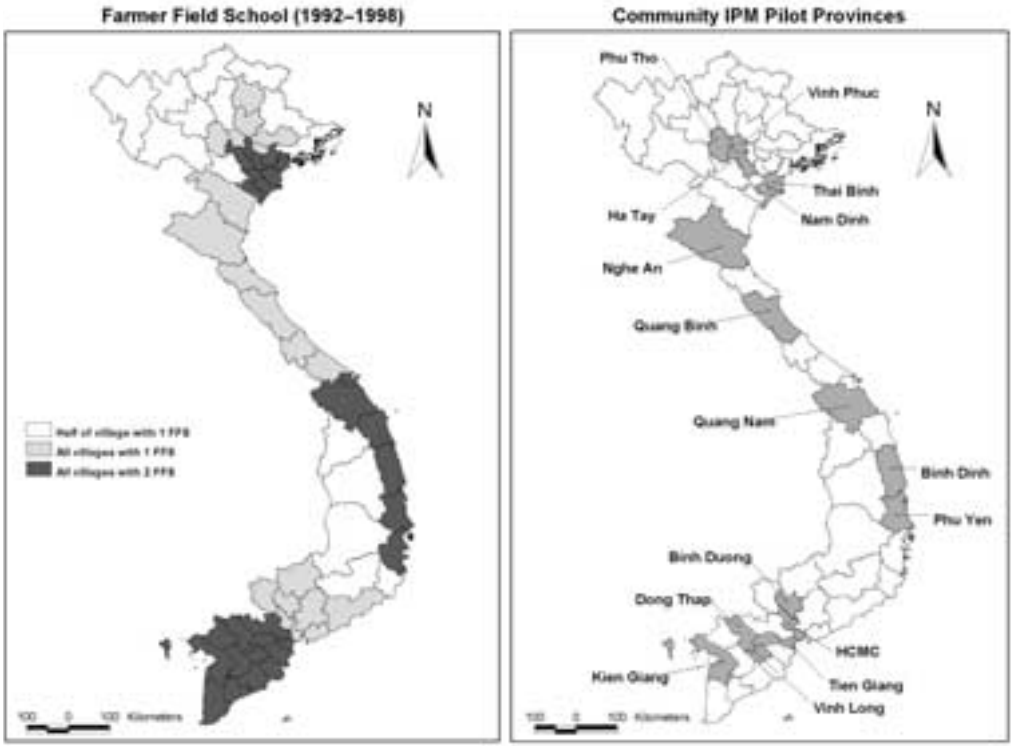
Map 2 IPM in 14 Provinces in Cambodia
Source: [Ngin Chhay 2002]

7) In Vietnam, the *doi moi* program led to a redefinition of the role of agricultural cooperatives, a return of the decision-making to individual household, and a renovation of the agricultural system. Farming was directed to meet the national and international markets [see Vo-Tong Xuan 1995; Tran Thi Que 1998; Yanagisawa and Kono 2001].

[Vietnam National IPM Programme 1999; 2003; FAO 2002]. The IPM Vietnam National IPM Programme is currently the largest one in Asia in terms of financial support for the current phase [Röling *et al*. 2000].

Indonesia, on the other hand, ceased its large-scale national IPM program under the responsibility of the Ministry of Agriculture after the termination of the World Bank/USAID support in 1999. In spite of the termination, CIPM was developed on the basis of the very large farmer-to-farmer IPM movement. IPM farmers' alliance has been established to organize and support farmer-to-farmer training, action research, farmers' studies, farmers' organization, and advocacy [Hidayat and Adinata 2001; also see FAO 2002]. The Mid Term reviewers' team for the FAO Inter-Country Programme for Community IPM in Asia [Röling *et al*. 2000: 14–15] concludes that the Indonesian programme:

> . . . continues to be the "kitchen" for the development of CIPM approaches, programmes and methods, serving as a source of ideas, experiences and expertise for other programmes in the region. . . . More importantly, the Indonesia CIPM has now become the largest scale farmer-to-farmer education and action programme in existence.



Map 3　IPM FFS and CIPM in the Provinces in Vietnam
Source: [Vietnam National IPM Programme 1999; 2000]

Such farmers' movement in Indonesia has occurred after more than three decades experiencing the cultivation of modern rice varieties and technological packages through the top-down extension system [Hansen 1978; Hardjono 1983; Fox 1991; 1993]. On the contrary, farmers in Cambodia have begun adopting modern rice varieties for dry season planting only. They keep planting their own traditional varieties for the long wet season planting which help preserving their knowledge of those varieties. No extension system has been well developed. In comparison to Vietnam with its *doi moi* program, Indonesia has a longer history of adopting the Green Revolution technology.

Despite a varied degree of farmers' acquaintance with the Green Revolution technology, their knowledge was not significantly different from one another. Knowledge was gained through everyday practices, trial-and-error, observation, comparison, farmer-to-farmer knowledge transmission, and receiving information from various external sources.[8] In Indonesia, the emphasis of technological transfer through a top-down extension services along with farmers' empirical observation and subjective interpretation constrained the advancement of farmers' understanding. Their ignorance grew as the unintended and unexpected phenomena emerged daily and seasonally.[9] Farmers in Cambodia and Vietnam describe their previous practices as only doing the works, directly participating in the works by following their parents' cultivation activities, or through "mimesis" (imitation) in Bourdieu's term [Bourdieu 1977]. In addition, the Vietnamese have been used to receive announcement, information, and instruction from the upper-level government down to local level through various means of mass media [see Diep Dinh Hoa *et al*. 1993]; and "speeches" (*dion thuyot*) in farmers meeting.

Into such a situation, farmers in the three countries similarly appreciate the IPM "schooling" as enhancing their knowledge. "Now we have the period of enlightenment, of improving our knowledge," compared the IPM farmer in Central Lampung to that of the Green Revolution era [Winarto *et al*. 1999; Winarto 2001]. The Vietnamese perceived the IPM learning as provided detailed, in-depth, systematic knowledge and enabled them to explain things that were previously "vague."

> "Before, we did the practice, but we can't say it, so we can't describe it," expressed a female IPM farmer in Thai Binh, Vietnam. Another male IPM farmer said: "There are some resemblances with what I had known before, but without good knowledge in-depth, not so clear. Some practices that we did, we did not understand. After the learning we understand more, in-depth." Others said: "My mind is now open," "I understand more the condition of each stage of the growth of plants." "It provides me with systematic knowledge, a complete knowledge from the beginning until the end of cultivation." (author's field notes 2003)

8) Farmers also learned from modifying control strategies as a response to pest/disease outbreaks; evaluating mistakes and unforeseen phenomena; gaining new understandings from field-experimentation, and sharing through daily conversation [see Winarto 1999].

9) Also, see Shiva [1993; 1995] for the consequences of the Green Revolution.

For the Vietnamese, IPM is a new kind of "science and technique transfer." Similar to this was the Cambodians' voice that the new learning improved their practices at each stage of rice growth that enabled them to increase their yields [also see van Duuren *et al*. 2002; van Duuren 2003].

In such a situation, analyzing the processes leading to those changes and not only the kinds of changes is significant. At this stage, it is still too early to say whether a new kind of farming culture replacing the Green Revolution technology has developed sequentially following the introduction of IPM. My analysis is focused on the first decade post to IPM. Thus, my study inclines towards the second meaning of evolution as stated by Rambo [1991],[10] i.e. to the "process" that has caused any different forms of farmers' knowledge and practices to exist. Along with the nature of IPM intervention in transmitting knowledge—not the technology per se—my account on the evolutionary changes in rice-crop farming will first focus on farmers' knowledge. Knowledge, as Barth [2002: 1] says, is: "what a person employs to interpret and act on the world." Examining the extent to which knowledge is employed to act on the world, how, in what situation, and how does it affect the existing knowledge is still in need. An evolutionary perspective on these issues will enable us to understand how knowledge within individual minds expand over time, and how such an accumulation of knowledge become the basis for ongoing changes in actions. To understand these phenomena, the connectionism approach in cognitive anthropology is beneficial.[11]

Learning and Creating New Schemas

Farmers' remarks of the advantages of IPM led my inquiries of how the formation of new interpretation schemas has improved their ways of thinking. Schemas, according to Strauss and Quinn [1997: 49], are:

> . . . collections of elements that work together to process information at a given time. [Furthermore, schemas] . . . reconstruct our memories of past events, determine the meanings we impart to ongoing experience, and give us expectation for the future. Schemas also fill in missing or ambiguous information. . . [Strauss and Quinn 1997: 49].[12]

10) See Rambo [1991: 24] for the two different meanings of evolution: (1) the *sequence* of life forms that evolved over time, and (2) the *process* that has caused these different forms to evolve.

11) The connectionism approach in anthropology is moving away from analyzing knowledge through a serial process of analysis to a multiple parallel processing of external stimuli simultaneously through the existing networks connecting the processors [see Bloch 1991; D'Andrade 1995; Shore 1996; Strauss and Quinn 1997; and Ross 2004]. In such an approach, the elements of knowledge are seen as being active within certain combinations because of the reception of certain stimuli. The more frequent the stimuli are received, the more established the combinations of those stimuli are within individuals. By doing this, the individuals have learned something from the environment [see Strauss and Quinn 1997].

What kinds of new elements did the farmers learn, and how do those elements contribute to the advancement of their knowledge?

Natural Enemies, Farmers' Friends and Helpers

Despite differences in agricultural development in the three countries, the striking similarity in the learning of the IPM farmers in all places is their new understanding of the category of predator/natural enemy. This was the "missing" idea in their previous knowledge. Accordingly, they did not understand the function of natural enemies as "farmers' friends," or "farmers' helpers" in preying upon pests as introduced by the IPM facilitators [see Winarto 1995; 1996; 1998].[13)] They just realize that the new category also covers insects that in previous classification belonged to pests, and thus, not all insects were in fact: pests. Following this understanding, the Cambodian and Vietnamese distinguish "good insects" or "helpful insects" (i.e. predators) from "bad insects" or "harmful insects" (i.e. pests). In Indonesia, the helpful insects were equated with their own for "animals that are not harmful to paddy" as different from those that are harmful [see Winarto 1996; 1998; 2004]. This term and category was also the most shared new element among the IPM farmers, including the metaphors they used. It was the most understandable term introduced throughout the training period, and had gradually become part of IPM farmers' vocabularies, memories, and—in combination with the other new stimuli—constituted the new schema of interpreting the role of insects in their fields [Winarto 1999; 2004]. The same curriculum of the training for both the trainers and the farmers led to the introduction and reception of the same terms, metaphors, and meanings of that new element in the three countries. Learning the role and function of natural enemies, identifying the insects belonging to this category, and basing farmers' pest control decisions on the population of both natural enemies and pests were the primary focus of the training. These were repeated weekly in the session of agro-ecosystem analysis.

This new element also reactivated their knowledge of the preying of animals (i.e. rats, grasshoppers) by other animals (i.e. frogs, snakes, cats, or birds) that are easily observable. The new stimuli reactivated the one that was already stored in the other layer of their minds, and for Indonesia's farmers, reconstructed their memories. "The only enemies left for rats

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12) Also, see D'Andrade's [1995: 179] definition of schemas as the organization of cognitive elements into an abstract mental object capable of being held in working memory with default values or open slots which can be variously filled in with appropriate specifics. Schemas can assist the individuals to face a particular situation or solve a certain problem. Furthermore, those actions can become stimuli for the same individuals in the future, or for other individuals, forming new extrapersonal structures or reinforcing existing ones. To what extent certain interpretation schemas can be operational, motivating individuals to form particular actions can also diverse among individuals, across time and situations. Individual schemas become cultural schemas when they become firmly established in a number of individuals [Strauss and Quinn 1997].

13) Examples of the other new elements are: parasitoid, ecosystem, agro-ecosystem analysis, economic threshold level, pest resistance and resurgence, population, and pest's life cycle.

nowadays are farmers and rat-poison," said an old farmer in West Java when he recited the past abundant of rats' natural enemies in the old days of cultivating rice. After gaining such new understanding, the IPM farmers in both countries acknowledged their previous ignorance of such a role for insects. Why?

Both Bentley [1992] and Richards [1980] say that farmers know more of the bigger size of animals/plants than the smaller ones and those beyond farmers' ease of observation [Bentley 1992]. Small size insects and the preying upon those insects by other small insects are not easily observable through daily practices and observation. With their earlier schemas of using pesticides for killing pests—referring to insects—and the absence of the role of insect-predators, the actions they took were spraying whatever insects found in their fields with pesticides. It is interesting to note that farmers in the three countries mentioned such ignorance despite some differences in pesticides use. The new element, thus, filled in the missing slot of information in their minds.

Pesticides, the Poison

The other missing information filled in by new ideas was the poisonous and damaging nature of pesticides for insect-pests and predators, and for their own field environment and health. Due to farmers' ignorance of the nature and works of chemical substance, and the unintended consequences of injudicious use of chemical pesticides, they could not explain: "Why is it that the more medicines we have, the more 'illnesses' attack our plants." A number of farmers in Indonesia raised this rhetoric question when remembering the condition prior to the introduction of various brands of pesticides. At that time, "illnesses" on plants were not as much and as frequent as today, despite the increased number of types and brands of pesticides available. In Indonesia, farmers have been used to name pesticides as "medicines" (*obat*). The term "medicine" refers to the meaning of "curing" plants while "killing" pests. As a result, farmers often explain their actions of spraying "medicines" for both curative and protective treatments of their plants. The immediate observable results that the pests fell on the ground/water after spraying, and that their plants grew "healthy" again afterwards constituted a proof for the efficacy of the particular "medicines" they used. In Vietnam, farmers also refer to pesticides as medicines against pest (*thuoc sao*—insect medicines). This is an example of how the introduction of a metaphor by the extension workers and outsiders in combination with observable phenomena had a significant impact in constituting farmers' interpretation schema for pest management.

Looking at how farmers in Indonesia perceive each stage of the growth of paddy as the growth of their own physical body, and take care of their plants if they get "sick" [Winarto 1996; 1998; 2004],[14] the use of the metaphor (medicines for poisons) proved to be fit in well with their cultural understanding of growing rice.[15] Quinn [1991: 65] in her arguments for

14）Also, see Tanaka [2002] for the individual oriented farming techniques in rice farming.

15）See Kuhn [1993], and Petrie and Oshlag [1993] for the essential role of metaphors in transmitting knowledge from a scientific domain to the real world.

the cultural basis of metaphor states that:

> . . . particular metaphors are selected by speakers, and are favored by these speakers, just because they provide satisfying mappings onto already existing cultural understandings—that is, because elements and relations between elements in the source domain make a good match with elements and relations among them in the cultural model.

The selection of the metaphor by the outsiders and the reception by the farmers illustrate Quinn's remark of such a good match. The sick-human body and the medicines to cure the body matched with the sick-plants and the "medicines" (poisons) to cure the plants (by killing pests). Those pesticides do not have curative function on plants, and that this substance kills "helpful insects" were thus new ideas for IPM farmers in the three countries. It provides an entirely different relation between the sick-plants and the poisonous substance. These new understandings then assist them to explain the puzzle of why there have been unprecedented pest and disease outbreaks despite the intensive use of "medicines" they were practicing.

Population Density of Pests and Natural Enemies

Another closely related element is the need to take into account the population density of both pests and predators as part of decision-making in pest management. The census taking requires them to learn how to carry out a detailed observation of the agro-ecosystem condition of their fields. Identifying and classifying the insects as either predators or pests are parts of the new elements they learned throughout the training sessions. Hence, naming which insects are pests and which ones are predators was part of the stories the farmers in both countries told me of their new knowledge. How did they learn that? Going into the fields, counting the stems of the rice hills, collecting the insects with plastic bags, identifying and classifying them, counting the number of each insects, drawing the results of their observations, calculating the balance between the two categories of insects, analyzing their fields' ecological condition, and deciding what to do next were the steps they had to do weekly (see Plate 1). For farmers, it was a direct practice in the field, encountered them with reality:

> "We discussed and talked and went out to the field. It was a reality. They said about stem borer, and you got the stem borer in the field. It was very close to reality, so I believe in it," said an IPM farmer in Thai Binh, Vietnam. (author's field notes 2003)

Plate 1 Agro-ecosystem Analysis
(West Java, Indonesia)

Farmers did not only learn of how to acquire knowledge in a more systematic and detailed way, but also to gain beliefs and confidence through the "reality" they found. This is the reality as perceived from their own ways of learning: i.e. through direct observation and findings. Confidence and belief are significant parts of strengthening farmers' knowledge and understanding [Winarto 2004].

The experiment-session to show that insecticides, the poison, did killing the predators, accompanied by another session of "making insect-zoo"—into which farmers placed both pests and predators so as to enable them observe the preying—also provide a way to strengthening the creation of the new relation between elements (plants, pests, predators, pesticides). Even though the relation of those elements is a novel one, the basic understanding of protecting plants has been part of their culture of growing rice. Thus, the introduced metaphor of predator as "farmers, friends and helpers" also fit in to the existing cultural model by replacing the role of pesticides to predators. It proved to work well in stimulating farmers' motivation and emotional feeling to being care to predators and not harming them. The poems and songs composed by the Vietnam IPM farmers illustrate how strong their understanding and feelings are towards the function of this new category of insects and their supposed-attitudes towards the helpful insects (see Box 1). As argued by Strauss and Quinn [1997], motivation and emotion play a role in strengthening the establishment of the schemas and in motivating or discouraging action.

Be More "Caring" to the Plants

Another significant learning as told by the Cambodian and Vietnamese was the need to be more "caring" towards their plants. They relate this caring attitude with the more careful practices—and some changes—they need to do at each stage of the plants' growth. Besides the novel way of pest/disease control, the Cambodian learned the need to reduce the amount of seeds, as well as the amount of seedlings in one rice-hill while transplanting. The other new practices were smoothing the land after plowing and harrowing, applying basal fertilizers and top dressing, reducing the inorganic fertilizers and increasing the composted manure. Looking at these "new improved practices," it is likely that through IPM FFS, the Cambodian also learned the intensified Green Revolution strategies, except those practices leading them to avoid the excessive use of chemical fertilizers and pesticides. Stories told by the Vietnamese of the need to be more caring also refers to the improvement in seedlings, transplanting, fertilizing, and pest/disease control. However, the Vietnamese learned to replace the excessive use of nitrogen into more balanced N-P-K fertilizers in a more appropriate amount. The latter again reveals that through IPM FFS some "Green Revolution technological packages" were also introduced to the participants. To be more caring to the plants were also part of the instruction by the authority down to the farmers in the Green Revolution package. Now, the caring has different connotation in relation to farmers' own initiatives to pay attention more to the healthy growth of their plants.

In Indonesia, the IPM farmers did acknowledge the changes of their attitude in cultivat-

Enjoying the look over the rural field scenery

I am a girl of water nymph
Flying on the field to search for pests
Micosa where are you going
Oh you turn out to be catching the brown plant hopper on the field
The green frog is standing to see
To catch the guy proboscis
To relieve his hunger
The ladybug is slowly walking around
To ask for the aphid which leaf he is hiding behind

As farmers what should we think
How to optimize the use of pesticide
To preserve the natural enemies
To kill the pests on the rice field
Hey sister and brother, hurry on
To bring the knowledge to make ourselves rich
IPM a class in our homeland
When it is coming back to the field
It must be successful

by Mr. Mong, IPM Farmer in Tan Hoa, Vu Thu, Thai Binh.
Translated by Mr. Do Trong Tan, June 23, 2003.

Box 1 A Poem Composed by an IPM Farmer in Vietnam (Thai Binh)

ing rice, i.e. to be more alert, and to pay more attention to and carry out a detailed observation of the plants' and the fields' conditions. "Now, farmers have to also carry out research while farming," said a diligent IPM farmer in West Java. However, at the early stage of learning IPM, the farmers in Indonesia did not experience significant changes in their knowledge of how to treat their plants and fields at each stage of rice cultivation. No major alteration of their "conventional Green Revolution technological packages" was enforced to happen through the FFS learning. Accordingly, the IPM "school for rice" was not perceived as difficult as the other ones for secondary crops [Winarto *et al.* 2000]. Hence, the novel ideas as learned by farmers in Cambodia and Vietnam—outside the learning for pest and disease control—were not part of the new elements the Indonesian learned from the "schooling."

In the early introductory years of IPM, the IPM farmers in West Java complained that only basic concepts and understandings and emphasis on pest/disease management rather than a comprehensive knowledge of rice cultivation were taught in the "school." Learning from this constraint, in the latter years, farmers in Central Lampung also decided to conduct

the Advanced FFS for rice, and FFS for secondary crops (soybean, advanced soybean, and chili) as the follow-up stage of the FFS for rice. They decided to consider the farmer-participants as IPM alumni only after accomplishing the training up to Advanced FFS for soybean [*ibid.*]. Despite the "primary" level of the FFS for rice as perceived by farmers, some IPM groups in West Java had been able to advance their knowledge of pests' life cycle, e.g. white rice stem borer. They also acquired detailed understanding of the pest's nature of infestation, and the appropriate control strategy for each stage of pest's life cycle [Busyairi 1999; Winarto 2004]. Such an understanding was absent among the Cambodian and Vietnamese farmers. Why are there such differences?

The standard method of the FFS with its discovery experiential learning approach was designed to be adapted to local ecological situation through the agro-ecosystem analysis, supplemented by special topics [see Pontius *et al.* 2002; Gallagher 2003]. The variation of the agro-ecological condition in each locale would therefore affect the focus and substance of observation and analysis, even within each country. In West Java in 1990–92, and again in 1996–97, the white rice stem borer outbreaks along the north coast region were continuously infesting rice for several seasons in a row. This stimulated the discussion of how to control them appropriately and effectively by understanding the pest's life cycle and its nature of infestation. In other places, controlling rats, brown plant hoppers, rice seed bugs or rice blast (a disease) became the major discussion and learning. Very severe pests/disease outbreaks were not reported in Cambodia and Vietnam, in particular in the central provinces of Cambodia where the use of insecticides was low during the wet season planting for traditional rice varieties. However, the state in each country has also its underlying agenda in implementing the program.

The launch of the IPM program in Indonesia was initially based on the central government and leading national scientists' main objectives to alleviate the recurrent outbreaks of brown plant hopper, improve the declining rice yields, and reduce the government's subsidies on pesticides and fertilizers [see FAO 1990; Fox 1991; Kenmore 1992; Pontius *et al.* 2002]. On the other hand, the objectives of IPM in Cambodia and Vietnam were to improve farming practices in a sustainable manner, by avoiding the unintended consequences and problems of the Green Revolution [Vietnam National IPM Programme 1999; Ngin Chhay 2002; Ngin Chhay, personal communication 2003]. The IPM programs are therefore an appropriate means to improve farmers' cultivation strategies through the weekly FFS training. The experimental plots in which farmers did a comparison of the IPM treatment and farmers' practices were used to introduce the new ideas as learned by the Cambodian and Vietnam IPM farmers.

Accumulating Knowledge and Changing Practices

Once farmers acquire new schema of interpretation, they are able to use that schema to

interpret plants' performance and fields' condition. New ideas and combinations of ideas of both the old and the new ones are continuously formed on the basis of daily, weekly, or seasonal observation and experience. The kinds of new ideas and propositions that are gradually formed, and the extent to which the new schema becomes the basis for action in rice cultivation reveal some similarities and differences in the three countries.

Evaluating Plants' Performance

While following farmers in Indonesia going back and forth to their rice fields, they used to tell me their interpretation of how healthy, or how bad and "sick" the plants in the fields were, either of their own or fellows' crops. They pointed to either the colour of leaves, the number of stems, the straight form of stems, the similar height of plants; and during grain formation stage, condition of panicles. Such an interpretation constitutes a significant part in evaluating their own or fellows' strategies, and in taking up decision of what they have to do next. Evaluating the growth of plants is a schema in which a set of elements (e.g. colour, height, stems, and panicles) is processed together at once while observing the crops. Understanding this, I was curious to know how the new interpretation schemas learned from IPM affected their indicator in evaluating the condition of their plants. I discovered that there was a similar change among the IPM farmers in the three countries, i.e. different interpretation they had after acquiring the novel ideas. However, I found a variation of their interpretation that is likely related to the differences of their learning. If the Indonesian farmers interpret the indicator by activating the elements of "sickness" and "medicines," the Vietnamese relate it to "hunger" and "fertilizers" besides "sickness" and "medicines for pests."

Prior to IPM learning, the Indonesian farmers perceived the change in colours at the vegetative stage as the indicator of "getting ill." As a response, they would do their best to purchase "medicines" to cure the plants. Even though their perspectives of treating plants as of treating human body have been kept in their memory, after learning IPM, the farmers in Indonesia would not be anxious when they found the change of colours of their plants. They did the observation first to decide what they have to do instead of going straight to purchase pesticides. In Vietnam, prior to IPM learning, farmers interpreted the changes from dark-green to yellow or yellowish-red as an indicator of lack of fertilizers. "If the plants look yellowish-red, they are 'hungry', so I apply more fertilizers (nitrogen)," explained an IPM farmer in Vietnam. As the Cambodian IPM farmers also said, deep dark-green was the best indicator of the plants growth at the vegetative stage that was then altered significantly after learning IPM.

> "If the plants look too green (dark-green) during vegetative stage, it is too much nitrogen. I do not need to apply some more nitrogen; or, there is a redundancy of nitrogen that provides more attraction to pests," explained an IPM farmer in Vietnam. (author's field notes 2003)

Since those understandings were not directly acquired from the IPM "schooling," I argue that farmers' own interpretation by activating the new schemas led to the formation of those novel indicators. It further reveals their ability to reinterpret the established schemas for assessing the growth of plants by using the new collection of elements. An enrichment of their schemas did occur.

Yields and Costs

It was not part of the main objectives of Farmer Field School's training in Indonesia to improve yields per se [see Pontius *et al*. 2002 for the objectives of IPM program]. Therefore, the IPM farmers in Indonesia made their own assessment of the novel practice, i.e. "planting rice without pesticides" by referring to the "conventional" value of evaluating the effectiveness of a particular cultivation strategy, i.e. on the best yields a farmer can produce. However, it is not possible to measure yields increase as the direct result of this strategy. Such a difficulty led to a skeptical attitude among some IPM farmers who had been able to produce high yields. On the other hand, those who understand the main aims of their learning would appreciate the benefits they experienced: saving costs from reducing pesticides use and thus improving profits, even though they would earn similar yields as before, or even less.

As intended by the IPM planners in Cambodia and Vietnam, yields increase was also part of the main objectives to gain. In reality, IPM farmers in Cambodia and Vietnam were able to relate the changes in yields with their modified practices in transplanting or fertilizing.

> "Before I got 30 *taings* [1 *taing* = 2 *taos* = 30 kg], but now when I follow IPM practice I can get up to 40 *taings* per hectare," explained a Cambodian IPM farmer. "Now I earn more than 200 kg/*sao* from using the balanced fertilizer of N-P-K. Before I earned 150–160 kg/*sao,*" assessed a Vietnam IPM farmer. (author's field notes 2003)

Since the yields of rice in Cambodia are relatively low, an addition of only very few amount of fertilizers input could have significant impacts on yields. Changes in fertilizers component by the Vietnamese also led to changes of plants' growth. This is a tangible result supporting farmers' ability to assess the changes in yields or conditions of plants with changes in fertilizers use.

The reduction of costs was mentioned by the IPM farmers in the three countries as the main benefit they obtained. This was related to the reduction of pesticides use for the Indonesian and Vietnamese, inorganic fertilizers for the Cambodian, and the amount of seeds for both Cambodian and Vietnamese. In Indonesia, the IPM farmers became aware that for decades they spent their money for the benefits of those who made profits out of their practices. Besides cost saving, making their environments more greenish and healthy were other new understanding farmers in the three countries learned. "The cleaner the vil-

lage is, the better the rice fields are," claimed some IPM farmers in Cambodia. This phrase refers to their efforts of cleaning up house wastes and dung in their own house yard to be used as composted manure in their fields.

From "Top-down" to "Bottom-up"

Learning from the history of the prior prominent role of agricultural cooperatives in Vietnam [Vo-Tong Xuan 1995; Tran Thi Que 1998] and the top-down instruction by using local mass media system, what changes happened when farmers learned to make their own decisions based on observation? Before the introduction of IPM into farmers' life, individual households had been given right to manage their own plots, but with services provided by the agricultural cooperatives. The IPM farmers in my field sites in Thai Binh told me that the way the information was provided was not being altered. However, the message was now changed into a "warning" of the need to be cautious of pest/disease outbreaks, and that farmers were expected to observe their fields and make their own decisions. If they need pesticides, they can purchase it at the agricultural cooperatives or at the *thuoc sao* shop. Another significant change was the recruitment of IPM farmer trainers to be head and members of the "Plant Protection Team" of the agricultural cooperative [see Diep Dinh Hoa *et al*. 1993]. They now have the responsibility to monitor the field and pest/disease population and make the recommendation on the basis of IPM principles. The IPM farmer trainer in Nguyen Xa, Thai Binh also mentioned his unique experience when he and his fellow IPM farmers decided to accept an offer by a rice company to multiply new seeds from China in their fields.

> While trying to follow the rules of preparing the plots and treating the seeds as determined by the seed-company, they argued against the obligation to spray the seeds nine times/season. They asked to reduce the pesticide spray, but their request was refused by the seed-company. Then, they went to the Plant Protection Sub-department in the province and asked the agricultural officials to provide IPM training to the seed-company officials to let them understand the IPM principles. The PPSD staff agreed to provide the IPM training to the seed-company officials. At last, the seed-company allowed the IPM farmers to reduce the pesticide sprayings on the experimental plots. (author's field notes 2003)

I found many similar stories of how the IPM farmers did a change and had to struggle, not only to change their own and fellows' practices, but also of the ill-wise recommendation or regulation by the outsiders (agricultural staff, government officials, pesticides-company and dealers, etc.). Their struggles have gradually become part of their life as experienced by farmers in Indonesia.[16)]

16) See Winarto *et al*. [2000]; Winarto [2002]; Hidayat and Adinata [2001]; *Media Jaringan Petani Indonesia* [2000–2002] for various stories of farmers' voices, strategies, and struggles to protect their right and to negotiate for a better treatment by those in the authority.

Response to Pest Outbreaks

Along with everyday experiences and observation, the individual efforts enriched the new created schemas, so as to provide new meanings to their world of rice farming. These new sets of meanings were processed at once while encountering the reality and changes in the fields. Knowledge enrichment was thus going on through the interaction between the intra- and extra-personal structures during and outside the "schooling," as well as through a continuous dialectic between their experiences and the new scientific concepts, terms, and propositions. This was the case when the IPM farmers encountered unprecedented phenomena in their fields, sometimes in the direction not as expected or as intentionally planned by the IPM facilitators, nor by farmers themselves.

The case of farmers' responses towards white rice stem borer continuous outbreaks on the north coast of West Java, Indonesia in early 1990s and in the mid-90s, was a good example to illustrate how the ecological condition provided an opportunity for farmers to reinterpret the existing phenomena, enrich their established schemas, or modify them through observation, actions, and evaluation. Farmers' knowledge of the white rice stem borer's life cycle and its nature of infestation provide a basis to develop diverse ways of pest control strategy. From a dependency on spraying or broadcasting granule pesticides as the sole control strategy, they developed a various kind of innovative practices [See Winarto 1996; 2004; Busyairi 1999]. See Plates 2 and 3 for examples of farmers' invention in controlling white rice stem borer.

The Development of Farmers' Science

Despite innovative practices, farmers also learned from experimental studies that have recently been acknowledged as "Farmers' Studies or Farmers' Science" (Studi-studi Petani, Sains Petani). This is a significant means to define, analyze, and solve their own problems according to local needs, resources, and ecological conditions. Conducting a systematic experimentation through comparison and repeated treatments have been common [see Berg *et al*. 2001]. The term Studi-studi Petani or Sains Petani have become part of Indonesian

Plate 2 Slapping White Rice Stem Borer Moths with Rubber-slipper-bamboo Sticks [Indonesia]

Plate 3 Handpicking White Rice Stem Borer Egg-clusters [Indonesia]

farmers' vocabulary [Busyairi 1999; Winarto *et al*. 2000; Hidayat and Adinata 2001]. In the formal newsletter named as *Media Jaringan Petani Indonesia*, a special rubric called "Sains Petani" was allocated for publishing the news of farmers' own discoveries [see *Media Jaringan Petani Indonesia*]. In various farmers' meetings such as workshops, seminars, and conferences from the village up to the national level, the organizing committee used to allocate a special session of "Sains Petani" where farmers can exchange the ways and results of their own discoveries.

In the recent years, two special Farmer Field Schools were developed, i.e. FFS for Sains Petani and FFS for Ekologi Tanah (soil ecology) [See Koordinator Umum IPPHTI Kabupaten Boyolali 2001 for FFS Sains Petani and Team MDL IPPHTI Kabupaten Sukabumi 2001 for FFS Ekologi Tanah]. Following the FFS for soil ecology, I noticed a very significant change in the ability of farmers to discover and explain puzzling things beyond their empirical observation, e.g. the soil physical nature, by using equipments, though simple. For examples, farmers used balloons to measure soil aeration, and electric light to know the ion-capacity-exchange in the soil. To know soil capability in retaining or absorbing water, farmers made experiments by pouring water into different types of soil found in their environment. Such experimentations were not the case in the beginning of IPM in early 1990s. Accordingly, how the condition of their soils was, was a question without an answer.

The interaction between the intra- and extra-personal structures in schema formation, however, is not simple. Even though my study in Cambodia and Vietnam needs to be enriched with a longer period of observation, my longitudinal study in Indonesia strengthens my argument that the extent to which knowledge becomes a basis for action is not only situational, but is also affected by a set of other factors. For examples, farmers' experience and resources, ecological conditions, ongoing pressures and/or enforced recommendations, agricultural policy and local community structure, farmers' social statuses, as well as belief, confidence, motivation, and emotional feeling [Strauss and Quinn 1997; Winarto 2004]. A clear example of this is the practice of spraying pesticides among the Indonesian in West Java.

The Struggle: "Conventional Practice" versus "IPM Practice"

Referring to their long history of adopting rice intensification packages and the internalization of using "medicines" as an integral part of their culture of growing rice, not all IPM farmers—at the early stage of learning IPM—would directly abandon this practice after having the new schema of pest-disease control. Some of them questioned the efficacy of such a strategy in protecting their harvests from any pest-disease outbreaks; or the benefits of reducing expenses for purchasing pesticides if they had to take risks of harvest failures. Others did not gain a strong belief of the "killing" of natural enemies in the fields at the time of pesticides spray, or questioned the congruency of the population growth of pests and predators at the same period of time [see Winarto 1996; 2004]. These are examples of how knowledge is stored in the minds even though it is not being activated, and how the activa-

tion of ideas is strengthened by confidence and belief. Moreover, these farmers were only part of those who had to struggle to survive towards the continuous pest/disease outbreaks in the situation where diverse new brands of pesticides were also introduced to them through various means supported by the authority's recommendations.

On the other hand, there were some IPM farmers in my field sites who were very consistent and persistent with their new schemas. They would try whatever they could to grow paddy without "poisons," even though with a risk of not producing the best harvests. Some IPM farmers in Central Lampung consciously used the word "poison" to replace the word "medicine" and criticized their fellows of using the incorrect term. Hence, there is a great variation in the extent to which the new schemas are turned into practice. There are also some diverse combinations of elements within farmers' minds at the time they are going to take decisions in pest-disease management practices resulting on different outputs leading to inaction, or action in diverse ways.

Despite the insignificant use of pesticides in Cambodia as compared to Indonesia, I also discovered farmers remarks that not all IPM farmers were able to get better yields, since not all of them followed IPM practices (by referring to the changes in transplanting and fertilizing they perceived as IPM practices). Hence, in spite of the variation in the ideas referred to while discussing the learning from IPM, a similar thing happened that the enrichment of knowledge could not automatically be an indicator of changes in practices. I also discovered in Vietnam, that a thorough understanding of the objectives and advantages of the new knowledge does not mean that a change from a prophylactic use of pesticides to decisions on the basis of observation would automatically occur. A leader of a local commune mass organization in Vietnam who could identify in detail the new learning she gained, but had many other tasks to do, asked her wage labourer to spray according to the "schedule," though the number of sprayings declined. For her, money to pay wages is not a problem. This is also a case where actors with a set of their social responsibilities play a role in knowledge formation and transformation. I discovered that those who define the strategies and evaluate directly the results of their own practices are those who are creatively find alternative ways to improve their farming practices and solve the puzzling phenomena they encounter.

Creativity and Diversity: The Evolutionary Path

Whilst the Green Revolution has been criticized for reducing heterogeneity in terms of biodiversity and farmers' practices [Shiva 1993; 1995], the phenomena I discovered following the introduction of the IPM was the increase of diversity, and the growth of farmers' creativity. Whereas diversity in ecological point of view leads to a greater stability and sustainability in an ecosystem, variability in anthropological point of view enables a culture to evolve [see Johnson 1972; Winarto 2001]. Johnson [1972] argues that in an environment where farmers

had to face dilemmas, risks and unexpected phenomena, their adaptation to local factors and problems is a creative one. Through creativity, farmers transform the environment while they are adapting to it [*ibid.*: 153–154]. Diversity and creativity are two closely related paths for an evolutionary change to occur.

IPM and Non-IPM Farmers

Diversity was an apparent phenomenon when—from the time the IPM FFS was introduced into a farming community in both countries—only a number of IPM farmers were recruited to participate. IPM "schooling" is an education means and not a mass-technological transfer. Only those who voluntarily expressed their willingness to join the "school" as in Cambodia, or those who were fortunately selected by the local authority as in Indonesia and Vietnam, were experiencing the enrichment of their knowledge. Such a selection and training method create a situation where only a number of farmers among hundreds of other farmers in one community had the opportunity to learn and exercise the new schemas through actions. In Indonesia, the IPM farmers' decisions for not spraying pesticides if unnecessary raised questions by their fields' neighbours of their inaction at the time of spraying. In a situation where farmers were not able to relate such a "strange" action to significant differences in yields, or pest/disease outbreaks, the means to transfer the new IPM ideas was only through verbal explanation. This is not quite a convincing way to having appreciation from those who did not experience changes in their schemas of growing rice.

I found similar stories of how the Cambodian and Vietnamese farmers observed the emergence of variation in the growing condition of plants and yields between the crops grown by the IPM and non-IPM farmers. In contrast to the Indonesian case, the more tangible results of yields in Cambodia and Vietnam due to some changes in fertilizers use provided a stimulating factor for the non-IPM farmers to know more, and to follow the changes after gaining some belief. Improving yields has been the main aim of farmers to achieve. In Vietnam, some non-IPM farmers were felt to be left behind in increasing rice production by being not selected as the participants of the "school." However, they had to admit the reality if the local authority did not select them to participate.

It is interesting to note that there are differences among the three countries in selecting participants, determining the location of FFS, and how many FFS will be conducted every year at the same or different places. In Cambodia, it is the National IPM Programme's decision that only one FFS would be held in one village, but the decision of who would be the participants is in the hand of the village leader. However, his decision depends on individual choice to join. The decision of where to run the FFS by the agricultural officials in Indonesia is no longer the case. With the withdrawal of foreign financial grants and the termination of the National IPM Programme in late 1990s, along with the increased number of IPM farmer trainers, the decision is now in the hands of the IPM farmers themselves. There is a great range of variation among diverse farming communities of how the local IPM farmers—who have institutionally formed an IPM farmers association (Ikatan Petani Pengendalian Hama

Terpadu Indonesia)—manage the dissemination of the new knowledge and strategies. In Central Lampung, the leaders of the local IPM farmers' organization called as Wakak Jukok (grass-root) decided to expand the number of FFS each season by also developing the advanced trainings, so that more farmers can have the opportunity to experience the learning process. The freedom experienced by both Cambodia and Indonesia who are now experiencing decentralization process in each own way, is not the case with the Vietnamese in terms of recruitment for joining that national program.

In Vietnam, the provincial agricultural officials in collaboration with the local agricultural cooperative determine the number and places of FFS in each season. The local leaders make the decision of who would be the participants in the next FFS. By referring to the written criteria of IPM participants and their knowledge of each member's talents and performance, the local mass organizations selected the registered farmers and provided the list to hamlet and village leaders. The latter submitted the list to the agricultural cooperative managing boards, the final decision makers. In one commune, the chief of the people's commune had to also prove the list. Such a selection process does not only reveal the existing community structure, but also the importance of the training as perceived by the local leaders. Even though some changes have occurred in the structures and relations of the community and mass organizations in Vietnam [Tran Thi Van Anh and Nguyen Man Huan 1995; Tran Thi Que 1998], decision-making on the community's affairs and needs has still been in the hands of local leaders. Yanagisawa and Kono [2001: 21] also conclude that the agricultural cooperative still play its role as in-between position (between the commune and farmers) in dealing with farmers' needs. This enables the cooperative to continue to play key roles in agricultural matters. Cambodia, on the other hand, is known for the lack of a rigid social structure in rural areas. Marston [1997: 79] says that hierarchy had very little stable institutional grounding in Cambodia. Ebihara [1966: 188] also argues that there is some truth in the assertion that independence and individualism are important to the Cambodian [see Steinberg 1959; Ebihara 1971]. In comparing Cambodia and Vietnam, Thion [1993: 25] says: "The Cambodian communal institution was far from having the same strong internal cohesion that was so noticeable in neighbouring Vietnam." To some extent, these variations affect the nature of how the new schemas are distributed in one community.

"Overheard Piecemeal Learning" and Farmers' Creativity

Another contributing factor for diversity to exist is the reality that the combination and collection of new elements as gained by the IPM farmers could not be transferred to non-IPM farmers as comprehensively as they learned from the "school." What becomes the topic of observation or conversation is very situational. Some non-IPM farmers in Vietnam could elicit the new ideas they learned from the IPM farmers in details—including the names of the predators and which insects prey upon which ones. Some farmers said that they only knew some new ideas through "overheard piecemeal learning." Thus, variation does prevail in the extent to which the new schemas were transmitted by the IPM farmers, and were reinter-

preted, and misinterpreted by non-IPM farmers through observation and conversation.

Even though there is a growing understanding of IPM knowledge and strategies among the farmers in both countries, heterogeneity does prevail, in particular with the Indonesian case. It is related to the improved farmers' creativity. Their curiosity and motivation to carry out their own studies and experiments increased as found in a diverse range of farmers' studies in Indonesia.[17] Furthermore, the very diverse kinds of studies provide very rich findings that contribute to farmers' knowledge enrichment. For their peers, the more varied practices provide an external circumstance to observe, examine, and further decide whether to follow those practices and discoveries. As a further consequence, a more effective and efficient practice could replace the old ones.

Following their own ability to discover new things, explain, and solve their own problems, farmers' dignity and self-confidence have been improved. "Give me a book, and in combination with my empirical observation and findings, I can take the role as a 'specialist extension worker'," convinced a young IPM farmer in West Java. "I know more than the extension worker about the details of white rice stem borer's life cycle and how to control it effectively," claimed an IPM farmer in West Java proudly. Confidently IPM farmers in Indonesia were presenting their own discoveries in various meetings among farmers themselves, and even among the scholars, and bureaucrats in workshops, seminar, and conferences. The development of various studies in the so-called Farmers' Science is a proof of farmers' own dignity and self-confidence as knowledge producers. Even though in Cambodia and Vietnam the term and activities of "Farmers' Science" as developed in Indonesia have not been well institutionalized yet among the IPM farmers, my informants in both countries did tell me of the experiments they did following their training, in their own plots or in a group (under the CIPM) [see Plates 4 and 5]. "In this season I make an experiment of transplanting young-age of seedlings, and one seedling only in one rice-hill. If the results are good I have the evidence to tell my fellows," voiced an IPM farmer-trainer in Cambodia. A further result I found is the development of new roles among some IPM farmers.

New Roles: Teacher, Facilitator, and Researcher

The IPM farmer-trainers in the three countries have indeed experienced changes in their positions as not only ordinary farmers, but also as knowledgeable ones. Since they were appointed to facilitate farmers in the IPM "school," farmers in Cambodia called them ***kru*** (teacher), the same meaning as used by farmers in Vietnam to call the IPM facilitators as ***giáo viên***. The IPM farmer-trainers became the resource persons to whom farmers ask questions. In Indonesia, the term for the same status is ***petani pemandu*** (farmer facilitators), not as a teacher. On the other hand, there are new identifications for those who are diligently and industriously carrying out observation, studies, and experiments as farmer-researchers

17) See the examples of various kinds of Farmers' Studies in *Media Jaringan Petani Indonesia* [2000a; 2000b; 2000c; 2001a; 2001b; 2002a; 2002b]; Busyairi [1999]; Winarto *et al.*[2000].

Plate 4 The “Composted-manure” Hut [Cambodia]

Plate 5 Leaving the Straw in the Field [Vietnam]

(*petani peneliti*), farmer-experts (*pakar petani*), and also as farmer-professors (*petani professor*) for the “very diligent and expert” ones [see Winarto 2004; Winarto *et al*. 2000].

In spite of such a variation, I argue for a significant change in the probability of individual farmers—characterized by those new capabilities—to survive and become effective models in their communities. If these farmers replace the old “model farmers” of the Green Revolution era (i.e. who were successfully producing high yields) as the leading models in rice farming, then a “natural selection” in rice crop farming culture is expected to occur. As argued by Boyd and Richerson [1985: 173],

> To demonstrate that natural selection is a force in cultural evolution, we must still show that individuals characterized by alternative cultural variants differ in their probability of surviving and becoming effective models.

A longitudinal study is necessary to discover whether such a natural selection will occur in the three countries. The IPM farmers’ creativities in their responses to white rice stem borer outbreaks in West Java reveal that such a tendency occurs. Those who previously were not considered as “model farmers” were then perceived as “farmer-professors” due to their industriousness in observing, questioning, and carrying out experimentation throughout the course of the outbreaks. The farmers’ creativity in modifying and developing new kinds of pest control strategies provide an opportunity for other farmers to question those “strange practices,” learn the reasons behind those actions, discover the results through observation and comparison, and assess the impacts on pest’s population and plants growth. Farmers were then able to decide which control strategies were more effective and which ones were no longer appropriate and then, should be abandoned. The case of white rice stem borer control strategies in West Java proves such a gradual change, i.e. from an ignorance of the pest’s life cycle, its nature of infestation on plants, and a uniform practice of controlling pests, to a rich understanding of the pest’s behavior and diverse control strategies according to the pest’s life cycle [see Winarto 1996; 2004; Busyairi *et al*. 2000]. However, a

varied degree of understanding and actions prevail which again enriched farmers' evaluation, thoughts, analysis, and actions. This is an ever-expanding experience.

Evolution in Rice-crop Farming: Is It a Reality?

It is a reality that gradual changes—rather than sudden ones—did occur following the IPM programs in Indonesia, Cambodia, and Vietnam. In different settings and locales with different history of agricultural development, the similar educational methods of introducing knowledge and technology while improving farmers' curiosity and creativity did produce an enrichment of schemas in growing rice. This is the significant difference of learning from the Green Revolution technological packages in a uniform-mass-top-down recommendation. It is not to dismiss the reality though that some new cultivation techniques introduced through the IPM FFS are also based on the "scientific agricultural domain." The gradual changes that follow reveal that once the farmers learn new elements—that fill in the missing slots in farmers' understandings of their rice ecology—together with adopting new ways of learning, an enhancement of various combinations of elements lead to an ongoing process of knowledge accumulation. The return of farmers' dignity and the enhancement of their creativity play a significant part in this process. However, this is only one contributing path for a gradual change in individuals' knowledge to occur. The extent to which knowledge is put into action—that is affected by various intra- and extra-personal structures that are locality based—together with diverse ways of recruiting participants and knowledge transmission contribute to a heterogeneous nature of crop farming to develop. Only with the provision of diverse features of growing crops does a natural selection occur, not only on the "best" practices in its new meaning, but also on the nature of farmers' expertise. These are the significant paths for evolutionary processes in rice-crop farming.

A comparative perspective in examining those phenomena in different countries proves useful in understanding and elucidating processes that lead to the formation of new meaning and interpretation in its similar or diverse ways. How the "culturally specific meanings" of the reality within its social and cultural context are formed, as well as how the processes of those meanings construction occur [see Holy 1987: 10–11], help us to understand how a certain feature of knowledge and practices evolve. Further queries can be carried out to discover why the processes that articulate or generate the observable diversity and similarity exist. These are the advantages in carrying out a comparative approach in examining the consequences of "IPM schooling" on several farming communities in Indonesia, Cambodia, and Vietnam.

A detailed ethnographic study is also beneficial in examining the formation and development of new schemas, and how the individual schemas—that were put into practices—became the extra-personal structures for other individuals. To what extent have the "shared IPM schemas" among the IPM participants become the "cultural schemas" of all farmers in

one locale? Have the gradual changes in knowledge and practices occurred among all farmers in a farming community? It has not always been the case for an "IPM cultural schema" to occur. Various programs of CIPM to disseminate the knowledge do not mean automatically that all farmers would understand what the IPM knowledge is. Thus, it is still a question of what the accumulative consequences of the current evolutionary changes are on their culture of growing rice in the future, in particular within the increased demands of high productivity and global international market. A further detailed longitudinal study is necessary.

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